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MIL-STD-1660 Tests

For

M55 Rocket Single Round Containers (SRCs)

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The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, to conduct evaluations on the M55 Rocket Single Round Containers (SRCs) unitized 3-high by 5-wide on a metal pallet. This report contains the procedures, results, and recommendations from the leak integrity tests and MIL-STD-1660 tests conducted. As tested, the M55 Rocket SRC pallet retained leak integrity following MIL-STD-1660 tests.

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REPORT NO. EVT 38-89

MIL-STD-1660 TESTS

FOR

M55 ROCKET SINGLE ROUND CONTAINERS (SRCs)

TABLE OF CONTENTS

PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), was tasked by ARDEC, SMCAR-ESK, to test the M55 Rocket Single Round Container (SRC). The MIL-STD-1660 compression, vibration, drop, and incline plane tests were done to determine whether the M55 Rocket SRCs were acceptable. Pressure transducers were used to monitor the internal pressure of the SRCs during the MIL-STD-1660 tests. Also, before the MIL-STD-1660 tests, the SRCs were pressurized to 15 psi with helium. Helium leak rate was measured before and after the MIL-STD-1660 tests to determine SRC integrity.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM).

C. OBJECTIVE. The objective of this series of tests was to assess the integrity of the SRCs and the suitability of the pallet assembly. These tests determined the suitability of the design to meet the MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

PART 2

ATTENDEES

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PART 3

TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies four steps that a unitized load must undergo if it is considered to be acceptable. The four tests that were conducted on the test pallet are synopsized below.

1. STACKING TESTS. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16 feet high for a period of one hour. This stacking load is simulated by subjecting the unit load to a compression of weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner. The unit load weight is divided by the unit load height in inches and multiplied by 192. The resulting number is the equivalent compressive load of a 16-foot-high stack.

2. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles-per-second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler gage may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieves one plus or minus zero point one G. Midway into the testing period the specimen shall be rotated 90 degrees and the test continued for the duration. Unless failure occurs, the total time of vibration shall be

two hours if the specimen is tested in one position; and, if tested in more than one position, the total time shall be three hours.

3. EDGEWISE ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Rotational Drop Test is as follows: The specimen shall be placed on its skids with one end of the pallet supported on a beam 4-1/2 inches high. The height of the beam shall be increased, if necessary, to ensure that there will be no support for the skids between the ends of the pallet when dropping takes place, but should not be high enough to cause the pallet to slide on the supports when the dropped end is raised for the drops. The unsupported end of the pallet shall then be raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP LEVEL A PROTECTION
600 lbs.	72 inches	36 inches
3,000 lbs.	no limit	24 inches
no limit	no limit	12 inches

4. IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test is as follows: The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4- by 4-inch timber may be attached to the bumper in the desired position

before the test. No part of the timber shall be struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7 feet-per-second.

PART 4

TEST EQUIPMENT

1. TEST SPECIMENS

a. VECP Drawing:	AC200000358
b. Unitization:	3- high X 5- wide
c. Pallet Dimensions:	6" high by 30" wide by 50" long (15.24cm by 76.20cm by 127.00cm)
d. SRC Dimensions:	6" high X 6" wide X 84.75" long (15.24cm X 15.24cm X 215.27cm)
e. Total Weight:	1,850 pounds (4,070kg)

2. COMPRESSION TESTER

a. Manufacturer:	Ormond Manufacturing
b. Platform:	60 inches by 60 inches
c. Compression Limit:	50,000 pounds
d. Tension Limit:	50,000 pounds

3. TRANSPORTATION SIMULATOR

a. Manufacturer:	Gaynes Laboratory
b. Capacity:	6,000-pound pallet
c. Displacement:	1/2-inch Amplitude
d. Speed:	50 to 400 rpm
e. Platform:	5-foot by 8-foot

4. INCLINED RAMP

a. Manufacturer:	Conbur Incline
b. Type:	Impact Tester
c. Grade:	10 percent Incline
d. Length:	12-foot Incline

5. HELIUM MASS SPECTROMETER

Manufacturer:	Inficon

PART 5

TEST RESULTS

A. PRELIMINARY TESTS. Prior to MIL-STD-1660 tests, preliminary tests were conducted to determine the effectiveness of the M55 Rocket SRC flange seal.

1. Dye Penetrant Test.

Tetrafluor, Inc., conducted the dye penetrant test on the O-ring seals. Fifteen percent of the seals were found to be unacceptable.

2. Helium Mass Spectrometer Test.

The Helium Mass Spectrometer was used to determine the leak rate of each SRC. First, the flanges were tightened to 600 in/lbs torque, then the SRCs were filled with helium to 15 psi and placed in a vacuum chamber to determine the cubic centimeters per-second of helium that leaked from the container at one atmosphere. Even though a less accurate method, the data was taken using three vacuum pumps since some SRCs did not yield a reading using two vacuum pumps. The data collected before and after the MIL-STD-1660 tests is shown in Table 3 (page 5-5).

3. Profilometer Test.

Readings were taken on the flange groove and the container surface. Thirty percent of the surfaces failed the finish requirement of 32. The data shown in Table No. 1 (page 5-2) is the average of four readings on each surface.

Table No. 1

Profilometer readings on SRC seal surfaces		
SRC Serial Number	Average Flange Groove Finish	Average Container Surface Finish
007	22	30
008	23	25
009	56	19
010	21	16
011	20	21
012	20	27
013	24	20
014	13	24
015	19	12
016	45	31
017	78	34
018	62	14
019	38	32
020	42	69
021	78	32

B. MIL-STD-1660 TESTS. The pallet tested was configured with three layers of five containers each on a 30- X 50-inch steel pallet and was secured with three 1-1/4-inch bundling straps (see photo #5). During the MIL-STD-1660 tests, the pressure of each SRC was monitored by pressure transducers (see photo #1 & #2). The pressure of each SRC before and after MIL-STD-1660 testing at 19.74 degrees Centigrade are tabulated in Table 2 below.

Table No. 2

Pressures before and after MIL-STD-1660		
SRC Serial Number	Initial Pressure 13:23 23 Oct 89 (psi @ 19.74 C)	Final Pressure 3:02 26 Oct 89 (psi @ 19.74 C)
007	15.223	15.419
008	15.229	15.380
009	15.208	15.174
010	15.106	15.235
011	15.152	15.417
012	14.836	14.968
013	15.221	15.295
014	15.349	15.509
015	15.136	15.188
016	15.294	15.366
017	15.284	15.249
018	15.134	16.038
019	15.080	15.174
020	15.038	15.292
021	14.879	14.887
Average	15.145	15.306

1. Stacking Test

The test pallet was loaded to 14,800 pounds compression for a period of one hour. During the test some damage to the stacking lugs was attained, although the load was not applied uniformly as it would be in stacking (see photo #3 & #4). No decrease in pressure was measured.

2. Repetitive Shock Test

During the 120 minutes of vibration, the pallet skids were lateral to the induced dynamic load. The test equipment during this cycle was operated at 235 rpm or 3.9 cps which achieved .037" to .112" clearance. The pallet was not tested with the skids parallel to the induced load, since the pallet size exceeded the size limitations of the transportation simulator. No damage was noted during this test.

3. Edgewise Rotational Drop Test

One side of the pallet base was placed on a beam displacing it 6 inches above the floor. The opposite side was raised to a height of 24 inches above the floor and then dropped. The first drop was on the front of the pallet parallel to the skids. The drops were then done on the left side, right side, then rear. No damage was noted during this test.

4. Impact Test

The incline plane was set to allow the pallet to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact until all four sides had been tested. Some rattling was evident, which may have been due to a previously broken spring. No decrease in pressure was measured.

C. FINAL LEAK TEST. Helium Mass Spectrometer Test was repeated to determine whether the SRCs had retained their integrity following the MIL-STD-1660 tests. The leak rates after the MIL-STD-1660 tests are compared to the previous leak rates in Table 3 below. These leak rates are given in terms of cubic centimeters per-second of helium that leaked from the container at one atmosphere. However, these readings were taken using three vacuum pumps, which inherently bring in more ambient helium to give a higher reading. A leak rate using two vacuum pumps, which would give a lower and more accurate reading, could not be used since not all containers yielded a reading. Approximately 1 to 1.5X10-5 could be attributed to spectrometer error from the three pump reading.

Table No. 3

Leak rates before and after MIL-STD-1660

SRC Serial Number	Initial Leak Rate (cc/He/atm/sec)	Final Leak Rate (cc/He/atm/sec)
007	4X10-5	5.5X10-5
008	6X10-5	5.5X10-5
009	3X10-5	7X10-5
010	4X10-5	4X10-5
011	4X10-5	3.5X10-5
012	8X10-5	8X10-5
013	4X10-5	7X10-5
014	3.5X10-5	6X10-5
015	3X10-5	6X10-5
016	4X10-5	7X10-5
017	9X10-5	7X10-5
018	4X10-5	5.5X10-5
019	4X10-5	5.5X10-5
020	4X10-5	8X10-5
021	4X10-5	6X10-5
Average	4.6X10-5	6.1X10-5
Two Pump Average	2.4X10-5	4.4X10-5

PART 6

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS.

a. Even though the profilometer readings varied, as can be seen in Table 1, this did not seem to affect the leak rate. However, Table 3 shows leak rates increased slightly after MIL-STD-1660 in many of the containers. The increased leak rate could be attributed to permeation through the seals, since the SRCs had been pressurized to 15 psi and may have become saturated with helium.

b. Three vacuum pumps were used in the process of obtaining the helium leak rate. A lower and more accurate leak rate would have resulted if two vacuum pumps were used, but not all containers yielded a reading. The average two pump reading from the containers was substantially lower than the three pump reading and would conclude that 1 to 1.5X10-5 cc/He/atm/sec could be attributed to error from using three pumps.

2. RECOMMENDATIONS.

Continue conducting engineering tests on other seals to upgrade leak integrity of SRCs against leakage.

PART 7

PHOTOGRAPHS

DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. 1 (90-865) This photograph shows the placement of pressure transducers.

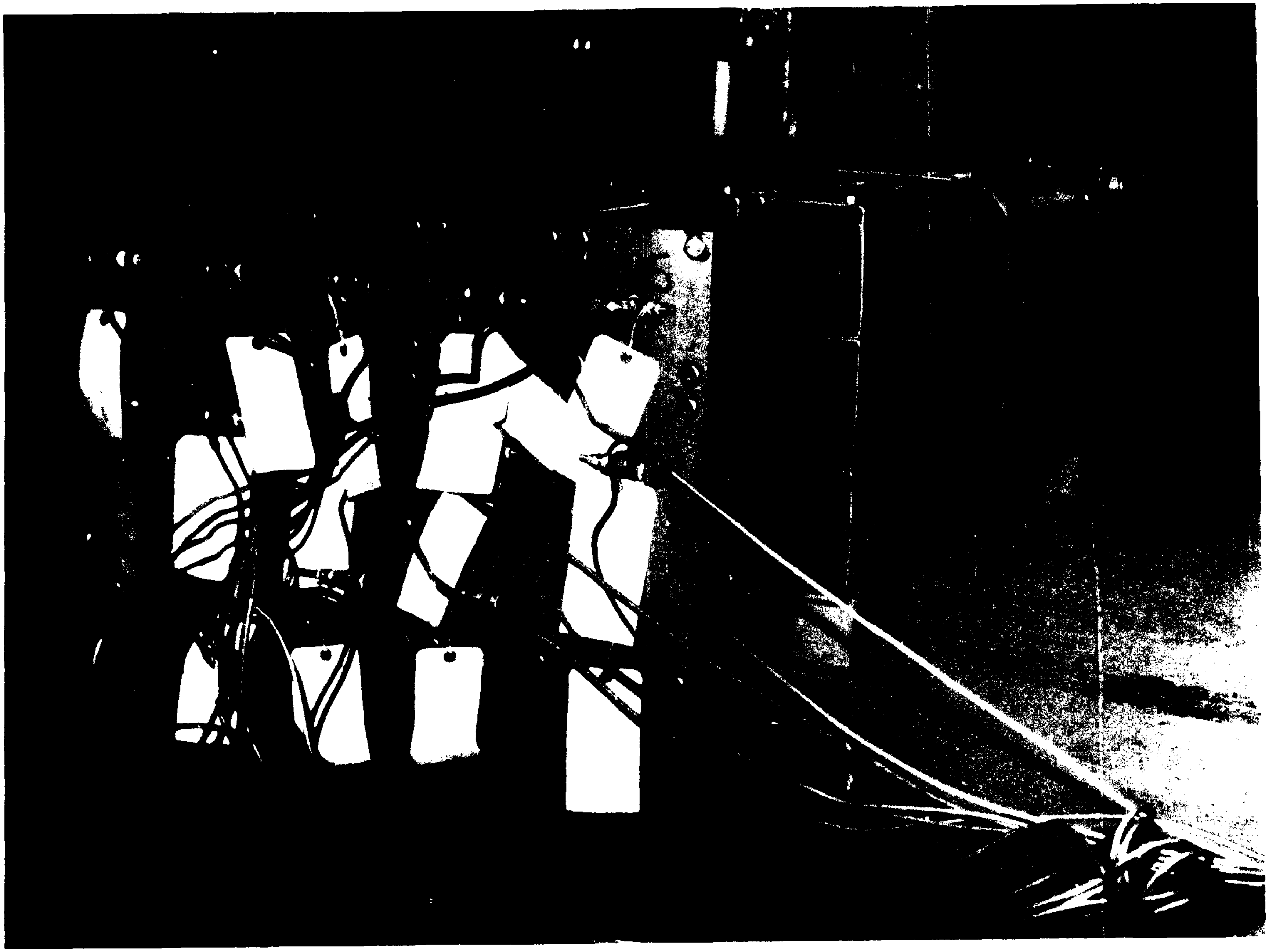

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Photo No. 2 (90-864) This photograph shows the placement of pressure transducers.

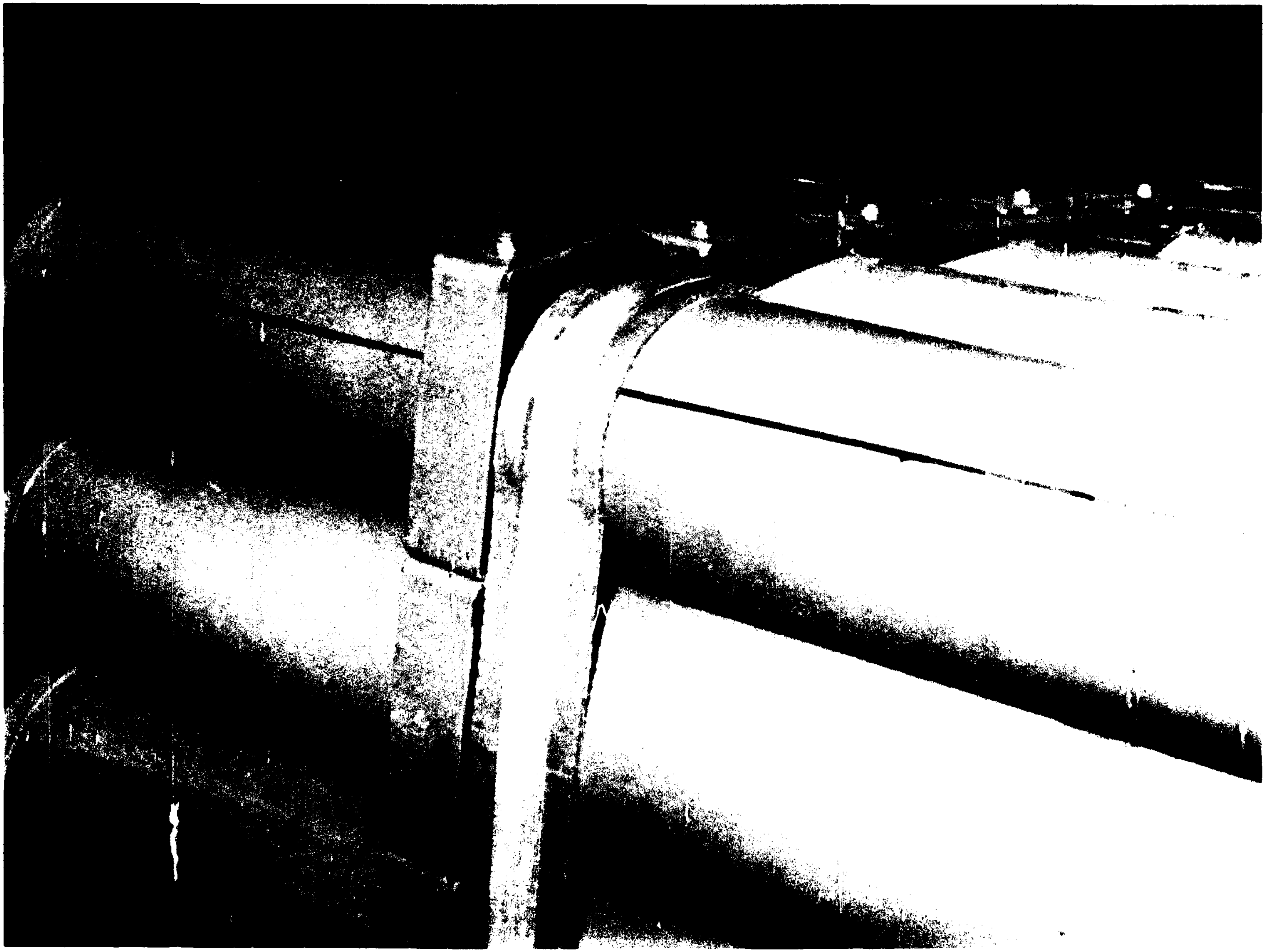

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Photo No. 3 [illegible] This photograph shows the [illegible] the compression [illegible]

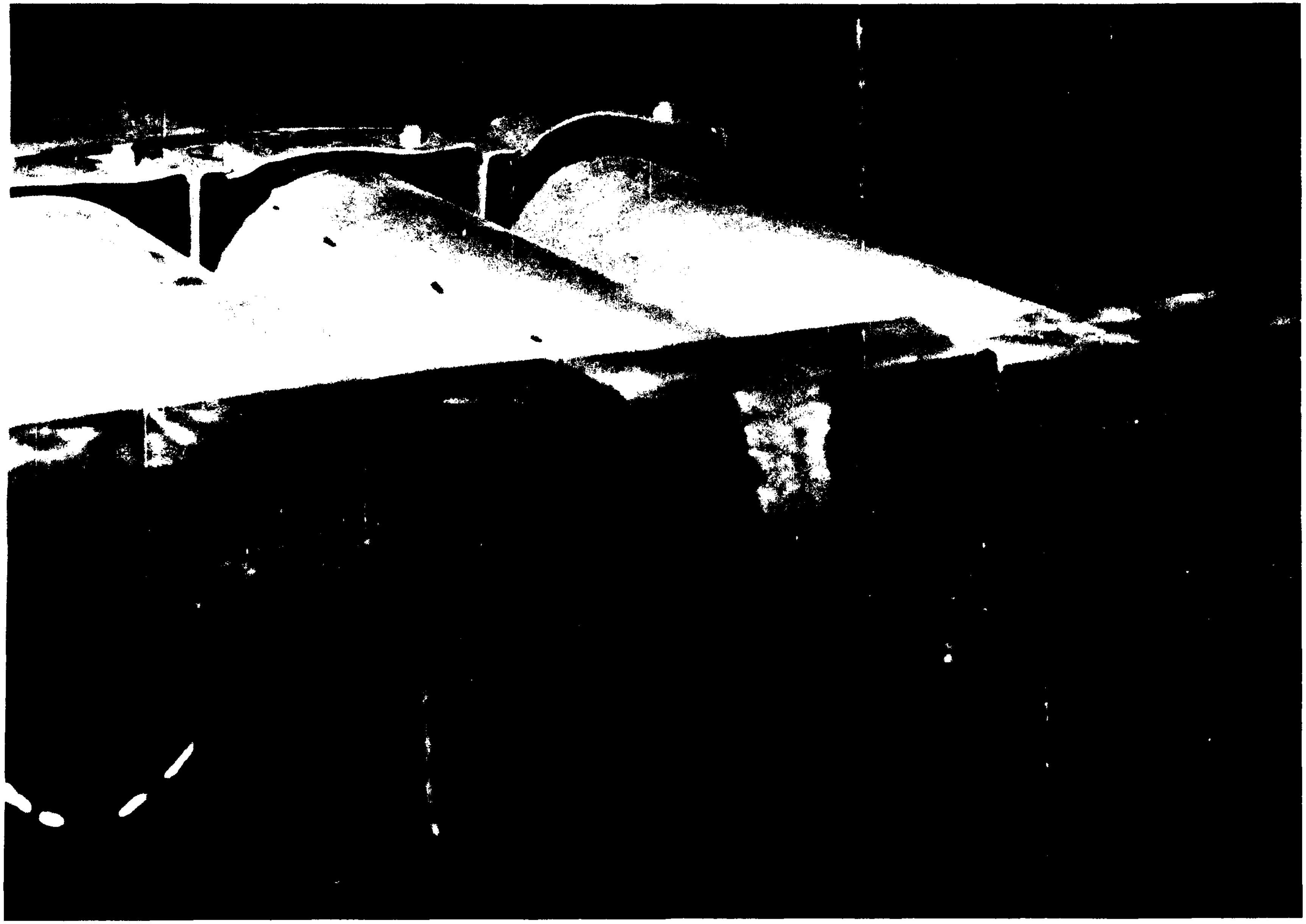

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Photo No. 4 (90-869) This photograph shows the damage attained by the stacking lugs from the compression test.

DEFENSE AMMUNITION CENTER AN[illegible]

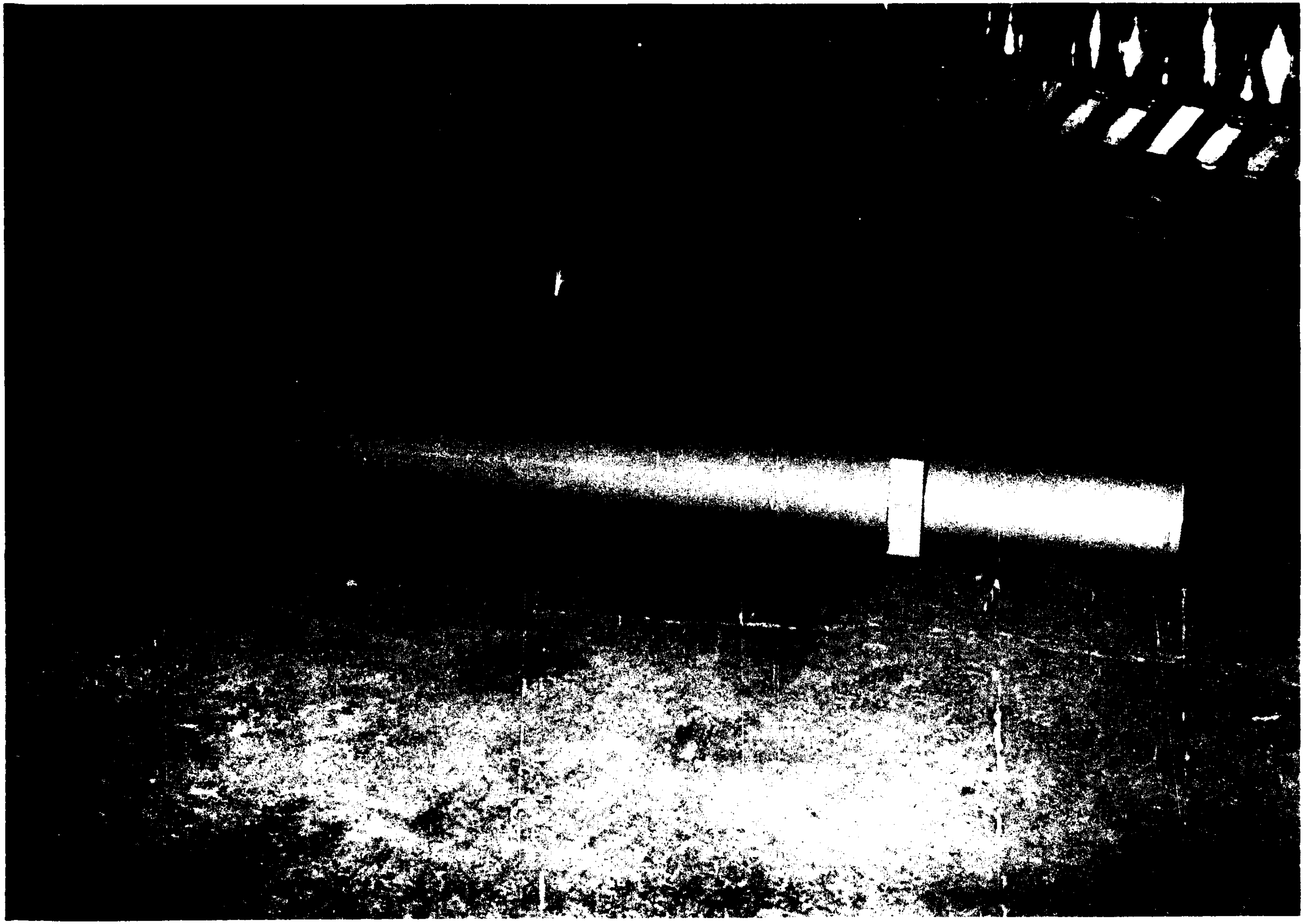

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Photo No. 6 (90-870) This photograph shows a single unpalletized Single Round Container (SRC).